TECHNICAL REPORT

70-15-FL

AD

COMPRESSED BEEF JERKY

by

R. L. Helmer and J. M. Tuomy

September 1969

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

Food Laboratory

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FOREWORD

The Food Packet, Long Range Patrol, is used by the Armed Services in Vietnam for patrol actions and other situations where resupply is difficult or not contemplated. It has been found to be excellent for this purpose, but users have requested a less bulky packet. In certain situations, food in a bar form would be desirable to be eaten out-of-hand. For these reasons, work is being performed on compressing foods with the ultimate goal of having food bars which can be either eaten out-of-hand or rehydrated to form a familiar food.

Jerky, a type of dried meat which has been used for centuries, has certain advantages if it could be modified to fit modern tastes. Moreover, it has a low bulk density and thus should be compressed for most efficient use. While it cannot be rehydrated to form a familiar food, it could be used in food packets until better bars are developed.

The work was performed under Project 1J6-62708-D553, Food Processing and Preservation Techniques and under Marine Corps MIPR M27/8/7616.

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ABSTRACT

A compressed beef jerky bar was developed which has promise for use by the Armed Forces in special stress situations for limited periods of time. The product is prepared by grinding lean beef, adding salt, and smoking it on screen trays until the moisture is in the range of 12 to 15 percent. The product is then compressed in a bar mold using 5,000 pounds per square inch pressure with a 10-second dwell time and packaged in a flexible film pouch. Ratio of compressed to noncompressed product is 1 to 3.

A 6-month storage study at 100°F indicates that the product has excellent storage stability. The water content is sufficiently low to prevent microbiological activity. Preliminary field tests indicate the product performs well for the intended purpose.

COMPRESSED BEEF JERKY

INTRODUCTION

The Armed Services have expressed a need for stable compact meat bars which can be eaten out-of-hand in emergency and stress situations. One of the bars developed which seems to have considerable promise is compressed jerky.

Jerky has been made in many countries. Called "biltong" in Africa and "charqui" in South America, it was customarily prepared by cutting lean meat into thin strips and drying it in the sun. Ziegler (1958) states that while most of the jerky made by the North American Indians was sun-dried, some of it was hung over fires or at the top of teepees in order to speed the drying and thus minimize spoilage during the process. The meat was smoked as well as dried.

The chemical components of wood smoke have some antibacterial and anti-oxidative preservative action with meat (Gibbons et al., 1954; Lea, 1933; Jensen, 1943). However, the main purpose of smoking is to improve flavor. The primary factor in the preservation of jerky and similar products is the reduction of water activity to a point where spoilage organisms cannot grow.

Water activity (Aw) is a fundamental property of aqueous solutions and is defined by the formula

$$Aw = \frac{P}{P_o}$$

where P is the vapor pressure of the solution and P_o is the vapor pressure of the solute. All microorganisms require water solutions in which to grow (Scott, 1957) and foods such as meat contain water solutions which normally will support growth. However, if the Aw of these solutions is reduced by some means to between .7 and .8, spoilage microorganisms will not grow. The Aw can be lowered by drying or by the addition of a substance such as salt which will depress the vapor pressure, or by a combination of both methods.

The old-time jerky was very dry, tough, and difficult to chew (Stefansson, 1946). Furthermore, the dried strips were not considered a complete food and were hard to pack. Therefore, although some jerky was used by war parties and by the fur trappers in North America, most of it was pounded into a fibrous, fluffy mass which was mixed with hot fat to make pemmican. In order to produce a jerky more acceptable to modern taste, it was decided to use a combination of drying, smoking, and salting. This was expected to produce a product with sufficient moisture to be compressible as well as chewable, yet with an Aw low enough to prevent spoilage.

EXPERIMENTAL METHODS

Jerky strips were prepared from U. S. Grade Commercial boneless chuck and U. S. Grade Choice boneless top round. The beef was defatted to less than 10 percent, frozen at -30°F, and cut into 1/4" wide and 1/4" thick strips on the band saw. The raw strips were then placed evenly on screen trays and salt was sprinkled over them. The quantity of salt used was 0.5, 1, 2 and 3 percent on a raw-weight basis. The product was then smoked at 100°F with heavy smoke for 2 hours, followed by a 200°F period with moderate smoke until the proper moisture level was obtained. Total time in the smoke house was 5 to 8 hours.

Ground jerky was prepared in the same way except that the beef was cooled to 36°F and ground through a plate containing 1-inch holes. The salt and ground beef were mixed, the product was reground through a plate with 1/2-inch holes and then spread evenly on screen trays.

Thirty grams of the smoked product were compressed in a 1 x 3-inch mold using 5,000 pounds per square inch pressure and a 10-second dwell time in a Carver Laboratory Press. Moisture levels from 10 to 24 percent were used to determine the best moisture for compression. After compression, the bars were sealed in a flexible pouch at a vacuum of at least 27 inches of mercury. Samples were stored at 100°F and tested by a technological panel at 4 intervals up to 6 months.

The water activity was determined by the static equilibrium method over saturated salt solutions (Salwin and Slawson, 1959).

RESULTS AND DISCUSSION

Preliminary taste panels indicated that while the bars made from strips were slightly preferred to those made from the ground jerky, the difference was not enough to rule out the ground product. Loss of meat during the sawing operation and handling problems with the strips indicated that manufacturing costs would be considerably higher with the strips. Therefore, it was decided to concentrate on the ground product for possible military use. The grades of beef had no effect on the taste panel results.

Compression studies showed that a moisture content of 12-15 percent gave the best compressed bar. Above 15 percent moisture, the bars relaxed so that they were difficult to package and would fall apart when the package was opened. Below 12 percent moisture, the product was difficult to eat and was powdered. In the 12-15 percent range, the compressed bar could be handled and eaten without difficulty. Ratio of compressed to noncompressed product was 1 to 3.

Table 1 shows typical analyses of the ground jerky converted to 13.5 percent moisture where varying amounts of salt were used. The fat is quite low for a dry meat product and the protein is high.

Table 1. Typical analyses of beef jerky converted to 13.5 percent moisture.

Meat used	Moisture	Analyses (%)		
		Fat	Protein	Salt
Choice Top Round	13.5	9.9	68.5	1.9
Choice Top Round		9.5	67.8	3.1
Commercial Chuck		9.1	66.1	5.3
Choice Top Round		14.0	57.1	8.7

Table 2 shows the average taste panel results for the compressed ground jerky stored at 100°F for up to 6 months. Analysis of variance indicated that the only significant storage effect was in texture, which showed improvement at the end of six months. The panel results indicate that the product is considered hard or tough and should be improved. However, a preliminary field test by the Marine Corps (Anon, 1969) where the jerky bar was part of an experimental food packet did not yield conclusive evidence that the texture should be changed.

Table 2. Average technological taste panel results* for ground compressed jerky stored for intervals up to 6 months at 100°F (12 member panel).

Property	At Storage Time (mo.)			
	0	1 1/2	3	6
Color	6.4	6.0	5.8	6.6
Odor	6.9	6.4	6.5	7.0
Flavor	6.3	6.1	6.4	6.8
Texture	5.0	4.3	5.5	6.2

* Each member rated each property on a scale of 9; then these were averaged.

Table 3 shows the 70 F moisture sorption isotherm values for the ground jerky as percent water on a dry basis. These values indicate that at all salt levels tested, the water activity would be under .7 and the product would not support microbiological activity. However, the product is hygroscopic and therefore must be properly packaged to prevent moisture uptake. The salt level used for taste panels was 3.5 to 4 percent in the final product; this is close to the range obtained with cooked bacon.

Table 3. Moisture sorption isotherm values of beef jerky bars at 70 F as percent water on the dry basis.

Salt in Finished Product (%)	At Water Activity (Aw)					
	0	0.12	0.33	0.52	0.75	0.86
2.00	0.18	3.23	6.00	9.75	19.46	27.95
3.50	0.20	3.47	6.00	9.61	22.55	34.24
6.25	0.13	3.66	7.05	9.23	31.23	46.05
9.00	0.23	2.72	5.29	8.11	43.80	64.66

In general, as now developed, the Beef Jerky Bars appear to be highly acceptable for the intended purpose. Field tests will be needed to determine whether changes (such as softening the texture) will be necessary. Preliminary field tests by the Marine Corps resulted in a favorable report (Anon, 1969). Stefansson (1946) stated that fur industry or fur trappers considered 1 pound of jerky to be equivalent to 6 pounds of lean meat. The lack of sufficient fat prevented the jerky from being used as the sole diet for anything but short periods. Ration designers must consider this in making up food packets.

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Grinding (comminution)	8					
Compressing	8					
Sodium chloride	1					
Beef	1		9			
Food bars	2		9			
Beef jerky bars	2		9			
Packaging			8			
Flexible			0			
Storage stability			8			
Field rations	4		4			
Emergency rations	4		4			